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COASTAL BEND GROUP
SIERRA CLUB

P.O. BOX 3512
CORPUS CHRISTI, TX 78404

Jose Eduardo Torres-6WQ-SG
Groundwater/UIC Section
United States Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Dear Mr. Torres:

Enclosed you will find a copy of the report I presented on behalf of the Coastal Bend Sierra Club (CBSC) to EPA officials Lauren Setlow of the Washington, D.C. office and George Brozowski of the Region 6 office on November 4, 2010, at the Public Information Meeting entitled EPA REVIEW OF STANDARDS FOR URANIUM AND THORIUM MILLING FACILITIES in Corpus Christi.

Since you are the project engineer now evaluating the Uranium Energy Corporation's (UEC's) application for an aquifer exemption in Goliad, County, and since the CBSC report includes data from the UEC/Goliad County case to illustrate how TCEQ's regulations allow uranium companies to use ***statistically invalid*** estimation methodology in establishing pre-mining baseline quality, I am sending this report directly to you now.

In particular this report documents with specificity that TCEQ's regulations allow uranium companies operating in Texas to choose locations of baseline wells and estimate groundwater restoration values by methods which are fundamentally statistically flawed. In fact, I believe that EPA's acceptance of these methods when they grant aquifer exemptions in Texas may interfere with its mandate to enforce the Safe Drinking Water Act.

If you would find more documentation helpful, I will be happy to provide it. (A copy of my CV is included in the enclosed CBSC report.)

Thank you for your consideration of this matter.

Venice Scheurich

Venice Scheurich, Conservation Chair
P.O. Box 10101
Corpus Christi, TX 78460

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EPA MEETING COMMENTS RE URANIUM: CORPUS CHRISTI NOV. 4, 2010

My name is Venice Scheurich.
I am the Conservation Chair of the Coastal Bend Sierra Club.

My remarks will pertain to statistical methodology used in deriving estimates for the Restoration Table standards for post-mining groundwater restoration. I have some expertise in both applied and mathematical statistics, and have included a copy of my CV with these comments.

Four years ago, when uranium companies intensified their interest in mining in several South Texas counties within our region, the Coastal Bend Sierra Club began studying the in situ mining process.

I believe the discoveries we made on statistical matters have an important connection to whether EPA is properly administering its mandate in the *Safe Drinking Water Act.*

I believe this because the statistical documentation attached to the following comments indicates that pre-mining baseline groundwater quality has been and is being incorrectly assessed by present State regulations.

What surfaced immediately in our study of uranium mining in Texas was the disturbing fact that post-mining efforts by companies to restore groundwater to pre-mining quality almost always failed. This was especially true for uranium. Therefore, my comments here are specific to uranium in groundwater.

In trying to understand why mining companies were not able to clean uranium out of the groundwater to levels they had agreed to when the Texas Commission on Environmental Quality (TCEQ) granted their permits, we focused on how the estimates for restoration values were obtained.

We learned that compiling a TCEQ Permit Application's Restoration Table which contains values for uranium and other components is a multi-step process.

To our astonishment, we found an extremely serious sampling design flaw in one of the very first steps of this TCEQ regulatory process.

The error is that TCEQ's regulations allow companies to *choose* locations for all baseline wells which provide samples for estimating pre-mining groundwater quality. These *selections* are made *after* the company has test results from hundreds of boreholes drilled during the exploration phase. Data from this biased, statistically invalid sample is then used in subsequent steps which are involved in establishing the Restoration Table.

I examined baseline data from three different mining applications in three different counties within our region and found that in all cases companies used data obtained from this type of biased sampling.

[SEE INSERT 1 FOR DISCUSSION.]

In addition to allowing companies to use statistically biased data sets to derive restoration standards, TCEQ's regulations also allow companies to calculate these estimated values by questionable interpretation and manipulation of the data.

To see if companies were taking advantage of this opportunity, I examined the actual results of the baseline data analyses in the three counties mentioned above. Predictably, in all three cases, the companies chose analysis and interpretation of data which tilted baseline restoration values in their favor.

[SEE INSERT 2 FOR DISCUSSION.]

And further, in reading TCEQ's responses to several sets of recent public comments, I found numerous examples of TCEQ's having recommended or defended use of erroneous statistical procedures in their uranium mining regulations found in 30 TAC Chapter 331 and in the March 6, 2009, edition of the *Texas Register* which discussed recent revisions in uranium mining regulations.

[SEE INSERT 3 FOR DISCUSSION.]

Having spent over two decades of my professional life teaching college mathematics and statistics, and having also done some statistical consulting, I found these fundamental statistical errors in the regulations perplexing.

It is disturbing that TCEQ's regulations contain no protocols to assure that samples are independent and representative, even though TCEQ's statements (March 6, 2009, *Texas Register*) repeatedly stress the importance of samples having these properties. (See INSERT 3.)

The implications of this absence of protocols are profound because statistically biased baseline samples are being used to estimate pre-mining groundwater quality. The resulting flawed process of estimating groundwater quality has a direct impact on whether EPA will grant an aquifer exemption and therefore whether the spirit and intent of the *Safe Drinking Water Act* have been violated.

Perhaps a main reason there are numerous serious statistical flaws in TCEQ's regulations and many of their official statements is, as we have learned, that the Agency employs no credentialed statisticians.

Given that EPA is responsible for granting aquifer exemptions prior to ISL mining and for enforcing the *Safe Drinking Water Act*, and given the ease with which a statistically unbiased sample of locations for baseline wells could be obtained in the production zone of the production area, the Coastal Bend Sierra Club asks the following questions:

1. What is the justification for EPA's continuing to accept estimates of pre-mining groundwater quality based on selected, biased samples when EPA makes decisions on whether or not to grant aquifer exemptions?

2. Does EPA's acceptance of flawed estimates of groundwater quality from a mining company's application for an aquifer exemption result in one or more violations of the *Safe Drinking Water Act*?

I am attaching three inserts and several additional pages of documentation to these comments to support and clarify the statement I have just made.

The Coastal Bend Sierra Club is grateful to the EPA for the opportunity to comment on this important matter.

Venice Schemich

11/4/2010

INSERT 1

The first example discussed below uses data from Uranium Energy Corporation's (UEC's) Permit Application UR03075 PAA 1.

The company applying for a 36 acre production area authorization in Goliad County, Texas, after drilling and analyzing data from more than 230 exploration boreholes in the proposed production area, chose 10 locations for baseline wells , which yielded estimates for the initial Restoration Table values. (See attached Figure 1-4, etc., dated August 25, 2008.)

Several months later, the company chose 8 additional sites and drilled more baseline wells. Data from these 8 wells was combined with data from the initial 10 wells and yielded revised estimates which were used to construct a new Restoration Table. (See attached Figure 1-4, etc., dated March 25, 2009.)

The company claimed that this larger sample size of 18 wells would provide more accuracy in estimates. This statement is, of course, misleading and false because the sample contains selection bias, which by definition is present in a non-random, selected sample.

[NOTE: All uranium values which I cite in my inserts are in micrograms per liter whereas UEC and TCEQ usually cite values in milligrams per liter.]

Not surprisingly, uranium values were much higher (mean = 218, median = 146) in the second set of 8 wells than they were in the initial sample of 10 (mean = 33, median = 21). Note that lumping the two data sets together to obtain revised restoration values based on 18 baseline wells yielded a mean = 115 and a median = 71.

Of course, no one knows what number a valid statistical sample, based on a systematic grid or random sample would have yielded. But it is clear that UEC's methods, which TCEQ's regulations allow, produce biased estimates.

Several years ago, a similar situation occurred when Uranium Resources, Inc. (URI) applied for a permit for a production area authorization, PAA 3, in Kleberg County, Texas. (See the attached Kleberg County documents.) Initially 11 baseline wells, BL8501 – BL8511, were selected and later 16 more were added. Again, the company had drilled hundreds of boreholes and analyzed the data before selecting sites for baseline wells.

The third example is from URI's Vasquez mine in Duval County, Texas. (See the Duval County attachment.) In this case, the initial estimate of 51 for uranium in the Restoration Table was based on a selected sample of only three locations for baseline wells. Several years later, URI selected two additional sites and the data from those wells was combined with the initial three to yield a uranium estimate of 33. For this mine, only five baseline wells were used.

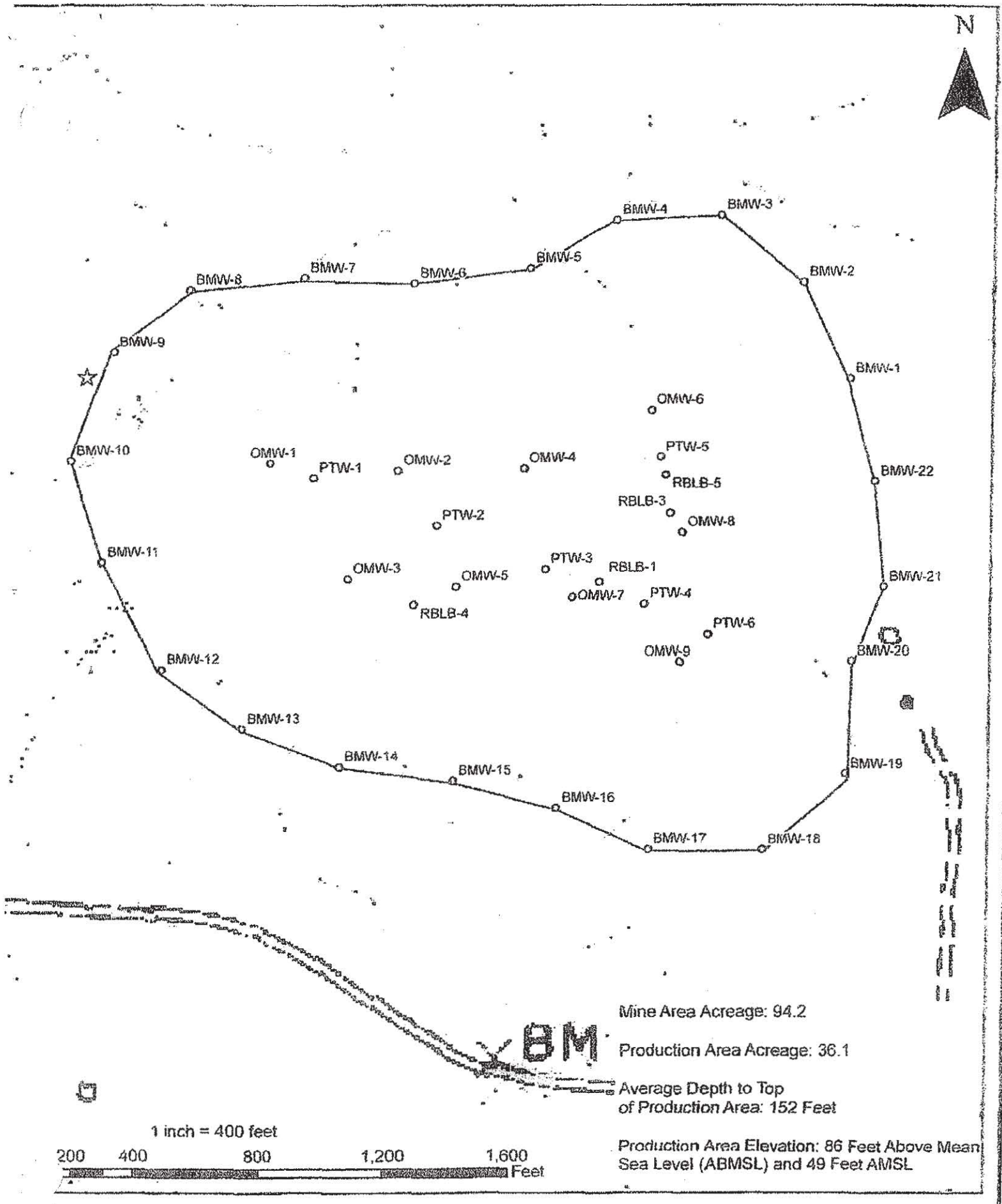


Figure 1-4 Draft

Production Area Map

- Baseline/Monitor Wells
- Production Zone: 36.147 Acres
- Mine Area Boundary: 94 155 Acres
- USGS Topographic Map
- Proposed Plant Site

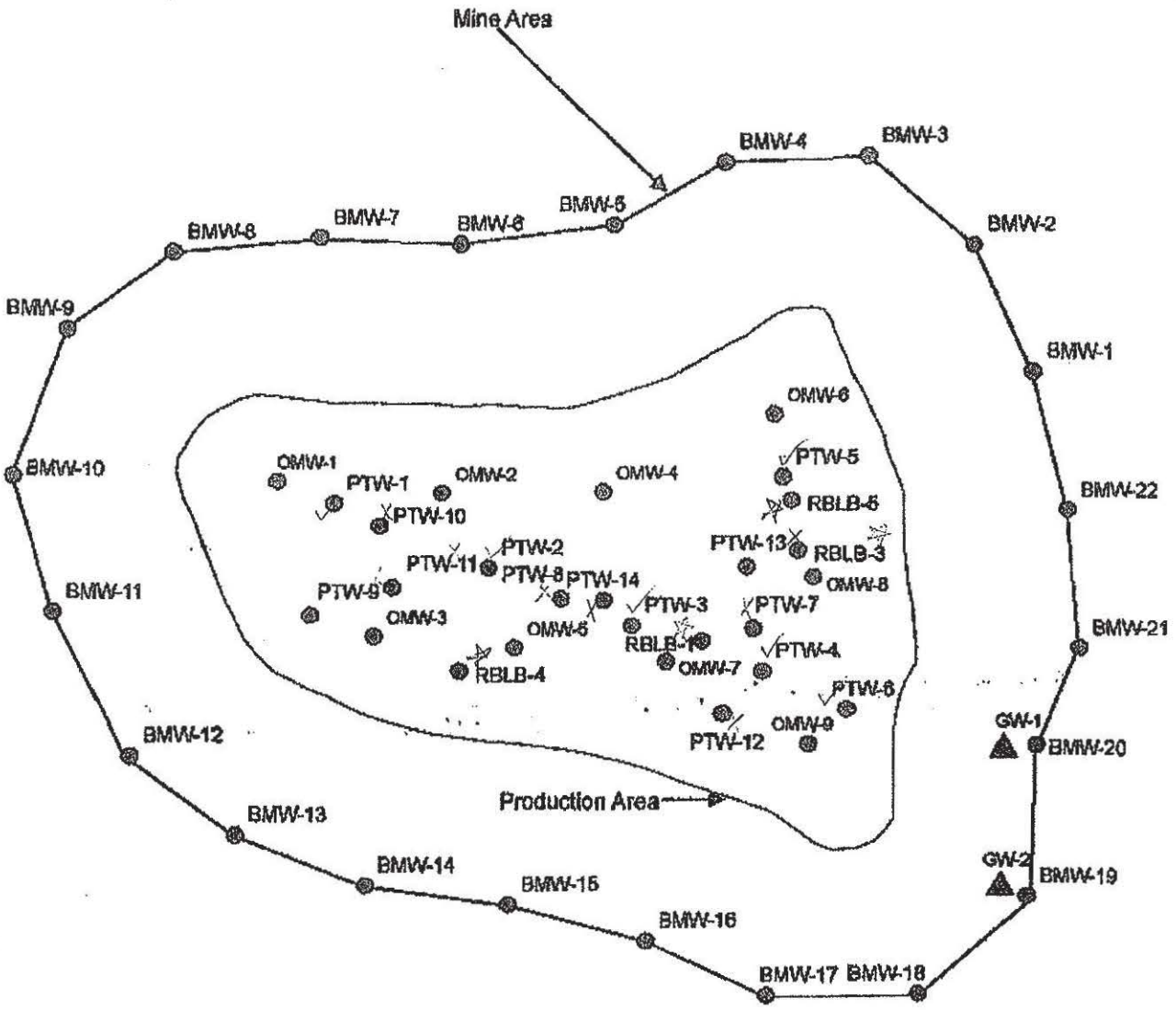
Drawn By: J.D.
Checked by: J.L. & C.H.
Date: August 25, 2008

[redacted] it can be seen that PA-1 has 36 acres of production area and 9 overlying monitor wells. The distribution of the wells above the 36 acre production zone provides significant coverage for monitoring purposes. The well pattern also served to allow baseline water quality to be assessed throughout the overlying 36 acre zone.

With respect to characterizing Production Area baseline water quality, § 331.104(a)(2) requires the collection of a minimum of one or more samples from at least 5 designated production zone wells. In developing Production Area baseline water quality, UEC exceeded the minimum requirement by completing 17 wells. Sample analyses from 10 of the wells are included in this submission. Seven additional wells are scheduled to be sampled in early September. TCEQ is planning to collect samples from some of the baseline wells during the September sampling period. UEC plans to supplement the production zone water quality baseline data with results from the upcoming sampling.

[redacted] throughout the Production Area will [redacted] and this in turn will allow for significant improvement in reaching the goals set out in the required Restoration Table.

[redacted]



Mine Area Acreage: 94.2 acres
Production Area Acreage: 36.1 acres
Average Depth to Production Zone: 152'
Production Zone Elevation: 86' above mean sea level (MSL) to 49' above MSL

Figure 1-4
Production Area Map
1 inch equals 400 feet

0 100 200 400 600 800 1,000 Feet

Legend
- Proposed Location of Production Zone Guard Well
- Overlying Monitor Well
- Production Zone Monitor Well

UEC

Figure 1-4
Drawn By: M.S.
Checked by: G.H. & J.L.

Referring again to Figure 1-4, it can be seen that PA-1 has 36 acres of production area and 9 overlying monitor wells. The distribution of the wells above the 36 acre production zone provides significant coverage for monitoring purposes. The well pattern also served to allow baseline water quality to be assessed throughout the overlying 36 acre zone.

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[redacted]

Expanding the number of samples throughout the Production Area will significantly improve the accuracy of baseline conditions, and this in turn will allow for significant improvement in reaching the goals set out in the required Restoration Table.

As described above on page 1-4, UEC actually installed 8 additional production zone baseline wells, and thus there is a total of 18 monitor wells in the production area.

by the pattern of uranium levels falling by two orders of magnitude from the first to the third round of testing. These declines were not sporadic. Indeed, these levels declined for all 18 baseline wells used for the PA-1 baseline water quality. It is worth revisiting Goliad County Cross-Examination Exhibit 1 from the hearing.[80] The decline in uranium concentration in the RBLBs and PTWs is uniform as seen below:

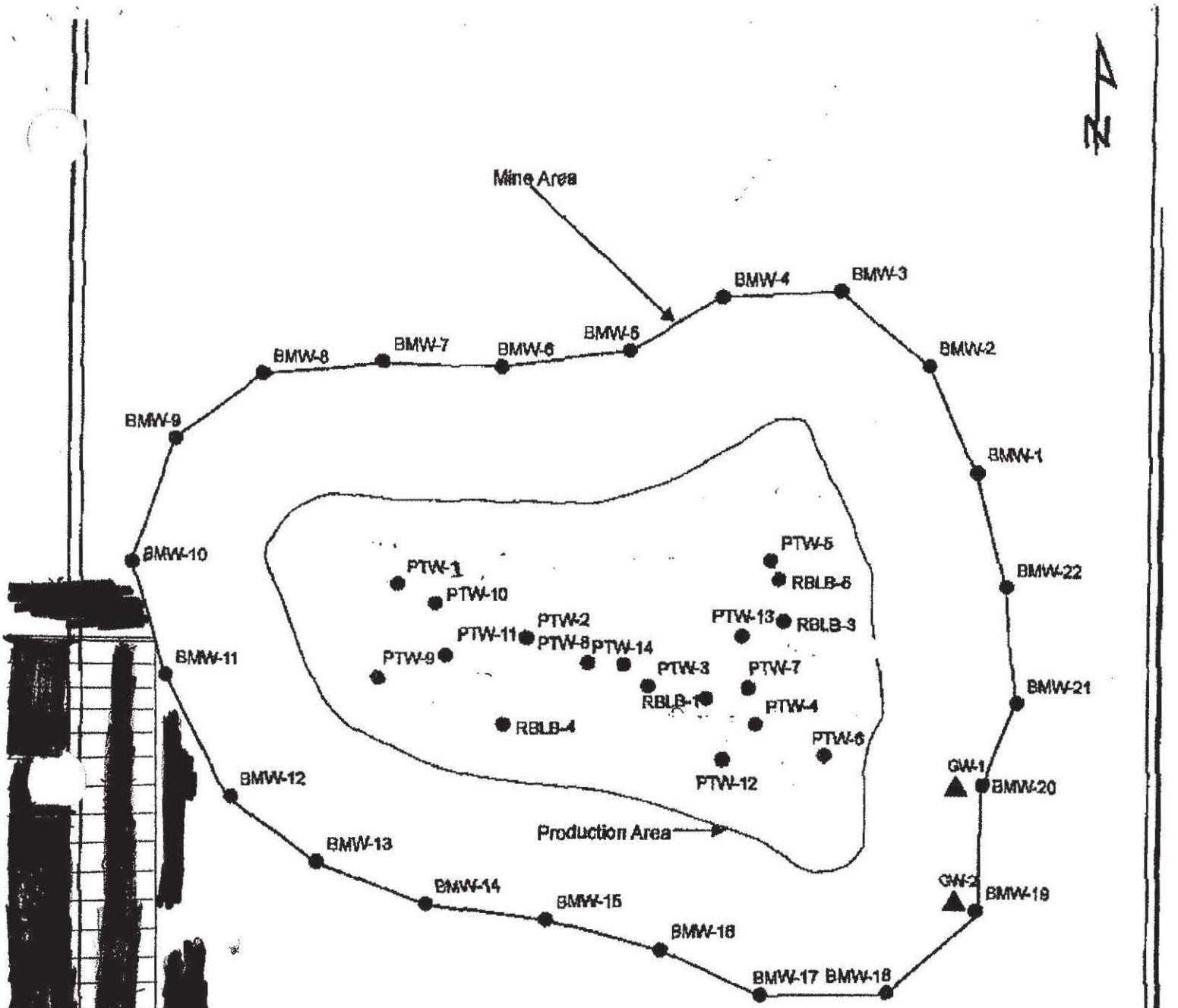
[redacted]

PTW	U-1 mg/l	U-2 mg/l	U-3 mg/l	Ra-1 pCi/l	Ra-2 pCi/l	Ra-3 pCi/l	1st Sample	2nd Sample	3rd Sample
1	0.032	<0.003	<0.003	17.0	38.0	16.0	4/29/08	7/14/09	11/16/09
2	0.009	0.014	0.004	17.0	17.0	10.0	4/29/08	7/15/09	11/10/09
3	0.009	0.03	<0.003	38.0	36.0	38.0	5/8/08	7/16/09	11/16/09
4	0.059	0.09	0.004	196.0	217.0	213.0	5/8/08	7/16/09	11/10/09
5	0.005	<0.0030	<0.003	357.0	549.0	830.0	5/12/08	7/21/09	11/16/09
6	0.010	<0.0030	<0.003	202.0	253.0	253.0	5/12/08	7/20/09	11/10/09
→ 7	0.804	0.010	0.005	1684.0	2000.0	1590.0	9/9/08	7/20/09	11/10/09
8	0.134	0.019	0.010	397.0	326.0	311.0	9/3/08	7/15/09	11/10/09
9	0.135	0.010	<0.003	394.0	343.0	306.0	9/8/08	7/14/09	11/16/09
10	0.099	0.020	<0.003	68.0	359.0	63.0	9/8/08	7/13/09	11/16/09
11	0.166	0.007	0.003	296.0	55.0	386.0	9/10/08	7/9/09	11/16/09
12	0.163	0.07	0.003	477.0	345.0	392.0	9/9/08	7/16/09	11/10/09
13	0.156	0.0160	0.006	10.0	324.0	208.0	9/9/08	7/20/09	11/16/09
14	0.086	0.005	0.007	224	198.0	157.0	7/2/08	7/15/09	11/10/09
RBLB									
1	0.062	0.07	0.013						
3	0.080	0.150	0.008						
4	0.006	0.004	<0.003						
5	0.060	0.005	0.003						
AVERAGE	**0.115**	**0.029**	**0.005**						
RANGE OF U VALUES	**0.009 - 0.804**	**<0.0030- 0.150**	**<0.003- 0.01**						

[redacted]

Mr. Murry from the TCEQ also testified that the numbers had changed from Round 1 to Round 2 and Round 3.[81] Mr. Murry did not evaluate this new data because it was not submitted to the agency by UEC but was instead provided during discovery,[82] further revealing the failure of UEC to timely provide new information to the TCEQ staff in violation of 30 T.A.C.

[80] Goliad County has electronically recreated Goliad County Cross-Examination Exhibit 1 and is incorporated herein as depicted.
[81] 7 TR. 1316:21 – 23 (Murry).
[82] 7 TR. 1313:1 – 4 (Murry).



[redacted]

Mine Area Acreage: 94.2 acres
Production Area Acreage: 36.1 acres
Average Depth to Production Zone: 152'
Production Zone Elevation: 86' above mean sea level (MSL) to 49' above MSL

[redacted]

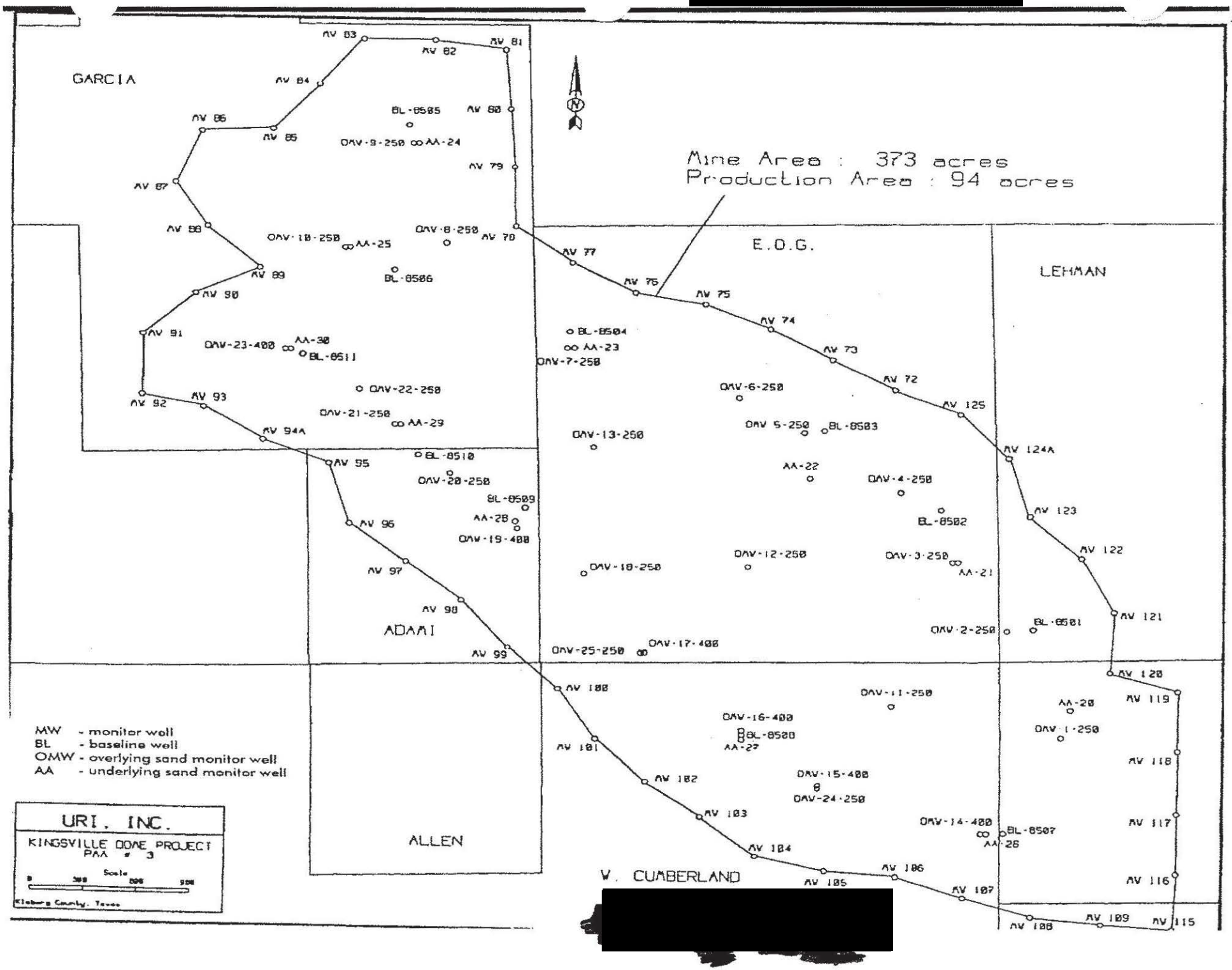
Figure 1-4
Production Area Map
1 inch equals 400 feet
0 100 200 400 600 800 1,000 Feet

Legend
Proposed Location of Production Zone Guard Well
Overlying Monitor Well
Production Zone Monitor Well

UEC

Figure 1-4
Drawn By: M.B.
Checked by: C.H. & J.L.
Date: March 25, 2009

[redacted]


GARCIA
E.O.G.
LEHMAN
ADAMI
ALLEN
W. CUMBERLAND
[redacted]
Mine Area : 373 acres
Production Area : 94 acres
AV 83
AV 82
AV 81
AV 84
AV 86
AV 85
AV 80
AV 79
AV 87
AV 88
AV 89
AV 90
AV 91
AV 92
AV 93
AV 94A
AV 95
AV 96
AV 97
AV 98
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AV 102
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AV 106
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AV 108
AV 109
AV 115
AV 116
AV 117
AV 118
AV 119
AV 120
AV 121
AV 122
AV 123
AV 124A
AV 125
AV 72
AV 73
AV 74
AV 75
AV 76
AV 77
AV 78
BL-8585
OAV-9-250
AA-24
OAV-10-250
AA-25
OAV-8-250
BL-8586
AA-30
OAV-23-400
BL-8511
OAV-22-250
OAV-21-250
AA-29
BL-8510
OAV-20-250
BL-8509
AA-28
OAV-19-400
BL-8504
AA-23
OAV-7-250
OAV-6-250
OAV 5-250
BL-8503
OAV-13-250
AA-22
OAV-4-250
BL-8502
OAV-12-250
OAV-3-250
AA-21
OAV-18-250
OAV-2-250
BL-8501
OAV-25-250
OAV-17-400
OAV-11-250
OAV-16-400
BL-8500
AA-27
OAV-1-250
AA-20
OAV-15-400
OAV-24-250
OAV-14-400
BL-8507
AA-26
MW - monitor well
BL - baseline well
OMW - overlying sand monitor well
AA - underlying sand monitor well
URI, INC.
KINGSVILLE DOME PROJECT
PAA # 3
Scale
Kleberg County, Texas

PAA-3 Baseline Wells
Pre-mining Water Quality Summary

Constituent	Units	Minimum	Average	Maximum
Calcium	mg/L	10	16	25
Magnesium	mg/L	1.5	3.8	6.0
Sodium	mg/L	203	387	480
Potassium	mg/L	7.7	16.1	31.0
Carbonate	mg/L	0	16	49
Bicarbonate	mg/L	95	165	321
Sulfate	mg/L	183	349	487
Chloride	mg/L	138	275	362
Fluoride	mg/L	0.00	0.19	2.10
Nitrate (as N)	mg/L	0.49	0.67	0.97
Silica	mg/L	17	20	23
pH	SU	7.69	8.70	9.6
TDS	mg/L	667	1143	1440
EC	µmhos	1120	1825	2820
Alkalinity	mg/L	78	162	263
Arsenic	mg/L	0.003	0.009	0.025
Cadmium	mg/L	<0.0001	NA	0.0001
Iron	mg/L	<0.01	0.01	0.04
Lead	mg/L	<0.001	NA	0.001
Manganese	mg/L	<0.01	NA	0.01
Mercury	mg/L	<0.0001	<0.0001	<0.0001
Selenium	mg/L	<0.001	0.014	0.063
Ammonia	mg/L	<0.01	0.18	0.40
Molybdenum	mg/L	0.02	0.30	3.20
Radium 226	pCi/L	0.3	23.3	78
Uranium	mg/L	0.032	0.351	1.54

Source:

Rice (2006)

Effects of URI's KVD Mine on Groundwater Quality

[redacted]

URI, Inc.
Permit No. UR03050

July 2008

[redacted]

RESTORATION TABLE

Parameter	units	1998 (PAA1) Concentration	2006 (PAA2) Concentration	Draft 2008 Concentration	EPA Drinking
Calcium	(mg/l)	86	54 (56)	57	
Magnesium	(mg/l)	60	33 (34)	34	
Sodium	(mg/l)	560	411	413	
Potassium	(mg/l)	34	24	24	
Carbonate	(mg/l)	1	2	2	
Bicarbonate	(mg/l)	341	381	363	
Sulfate	(mg/l)	150	92 (94)	107	**250
Chloride	(mg/l)	906	538	557	**250
Nitrate-N	(mg/l)	0.01	0.01 (.00)	0.06	*10
Fluoride	(mg/l)	1.10	0.84 (.82)	0.94	*4
Silica	(mg/l)	57	49	48	
TDS	(mg/l)	2044	1427	1438	**500
Conductivity	(µmhos)	3573	2480	2488	
Alkalinity	(mg/l)	280	312	301	
pH	(s.u.)	7.95	6-9	6-9	**6.5 – 8.5
Arsenic	(ug/l)	61	40	41	*10
Cadmium	(ug/l)	0	0	.2	*5
Iron	(ug/l)	30	40	50	**300
Lead	(ug/l)	0	0	0	
Manganese	(ug/l)	20	20	20	**50
Mercury	(ug/l)	0	0	0	*2
Molybdenum	(ug/l)	180	80 (90)	140	
Selenium	(ug/l)	1	1	5	*50
Uranium	(ug/l)	45	51 (10)	33	*30
Ammonia-N	(mg/l)	0.15	0.52	0.41	
Radium-226	(pCi/l)	78.93	78.90	50.54	*5

* Primary Drinking Water Standard Listed Contaminant

** Secondary Drinking Water Standard Listed Contaminant

( ) value that should be listed

[redacted]

[redacted]

URI, Inc.
Permit No. UR03050

July 2008

Permitting History of Vasquez Project

Base Permit

May 1991 - URI submitted applications to TWC and TDH.

Aug. 15, 1997 – Initial Base Permit issued by TNRCC.
Contained one production area authorization (PAA) of approx. 454 acres.

July 17, 1998 – EPA approved aquifer exemption.

Production Area PAA1

September 24, 1999 - issuance date.
PAA1 approx. 154 acres, PAA2 approx. 89 acres (Attachment D).

October 15, 2004 - mining operations begin.

Production Area PAA2

November 23, 2005 – issuance date.
Mine area 102 acres, production area 34 acres (Attachment 1).

Base Permit

April 25, 2006 – amended.

Production Area PAA2

August 2006 – mining operations begin.

October 3, 2006 – amended; expanded (5 acres) northwest corner of PAA to the west, replaced MWs 55-58 with MWs 28-31.

August 13, 2007 – request for amendments; add baseline wells MW55 and MW56, revise restoration tables.

Waste Disposal Well Permit - issued Nov. 3, 1980, WDW185 put in-service 9/1981.

TCEQ Handout

INSERT 2

In all three cases which were cited in INSERT 1, the selected samples of baseline well locations yielded data sets that were skewed upward.

The most striking example of TCEQ's allowing companies to use inappropriate manipulation of data to obtain an estimated baseline and restoration value for uranium in groundwater is seen in the following data set from URI's Vasquez mine in Duval County. (Recall the Vasquez mine attachment to INSERT 1.)

Following are uranium values (micrograms per liter) from five baseline wells: 2, 7, 8, 15, 131.

This sample yielded a mean = 32.6 and a median = 8.

TCEQ regulations in 30 TAC 331 allowed URI to use the sample mean of 32.6 as an estimate without any discussion of or adjustment for the impact of the 131 value, which is clearly an outlier.

This is allowed in TCEQ's regulations despite the fact that the statistical literature makes it clear that the use of the sample mean to estimate the central tendency of a distribution is only appropriate when a random (statistically valid) sample indicates that the population from which the sample is drawn follows a normal or lognormal distribution.

Unfortunately, the selected sampling which TCEQ allows prevents the necessary test (Shapiro-Wilk, for example) from being legitimately performed to establish whether the sample provides evidence that the population values follow such a distribution.

In spite of the 131 value's being a clear outlier, and in spite of the non-randomness of the sample data's preventing the appropriate test from being performed, TCEQ's regulations allow the sample mean of 32.6 to be used as the estimate of pre-mining uranium content in the groundwater, and that value is then also used as the post-mining restoration standard for uranium.

Noting that the uranium estimate of 32.6 exceeds the EPA safe level of 30, but the median of eight is far below EPA's maximum allowable level for uranium in safe drinking water, it is clear that this statistical issue could sometimes be crucial in whether or not EPA grants an aquifer exemption.

INSERT 3

Some of TCEQ's erroneous recommendations regarding use and interpretations of statistical methodology can be found, for example, on pp. 62-63 of the November 6, 2008, *Executive Director's Response to Comment Permit No. UR03075.*

On page 62, in comment 96, the Goliad County Groundwater Conservation District (GCGCD) asked what valid statistical procedures are used to test if the sample data indicates a normal or lognormal probability distribution.

The Executive Director, in Response 96, states: ". . . The Executive Director recommends use of the Shipiro-Wilk Test (for 50 or less sample results) and the Shipiro-Francia Test (for over 50 sample results) for making a decision to accept or reject normality or lognormality of a data set."

Since these tests are from the realm of inferential statistics and require that the sampling design include a random component, which was not the case in obtaining baseline wells, it is a serious statistical error to recommend that such a test be performed in this case. (Refer to paragraphs six and seven of INSERT 2.)

For another example in this November 6, 2008, document of TCEQ's defending a seriously erroneous practice, which their regulations allow and which companies take advantage of, see page 63.

Note Comment 97 in which GCGCD asked if it is TCEQ's policy to allow the sample average of data to be used when the distribution is not normal or lognormal. The Executive Director's Response 97, states: "The Executive Director allows averaging of data if the data are from a continuous distribution. 'Averaging' is equated with the statistical procedure called 'X-bar', which adds all the values and divides this sum by the number of values. It also is called the sample mean. This method is an estimation technique and is used to estimate the true mean of the distribution. It is the best linear unbiased estimation of the mean of any continuous, infinite distribution and is the minimum value unbiased estimator of the mean for a normal distribution." [Emphasis added.]

There are two serious errors in Response 97:

1. The last sentence in Response 97—". . . minimum value unbiased estimator. . ."—is not true unless the sampling involves a random step which is not the case in the selected sample of locations for baseline wells.

2. It is unlikely that the mean of a small, skewed selected data set will provide a good estimate of the population mean.

Other examples of serious statistical errors being allowed, recommended or defended by TCEQ exist in this document.

More statistical misinformation from TCEQ is found in the January 28, 2010, *Executive Director's Response to Public Comment* taken at the Goliad, Texas, public meeting re UR0375 PAA1 on October 5, 2009.

An illustration of this is found on pages 44-45 in TCEQ's Response 62 to Comment 62.

In Comment 62, TCEQ was asked by the Coastal Bend Group Sierra Club (CBGSC) to explain how Uranium Energy Corp. (UEC) guarded against selection bias when they chose locations for baseline wells.

The Executive Director's Response 62 states: "The Executive Director evaluated the location of the baseline wells by visual inspection of well locations in Figure 1-4. Baseline wells are distributed throughout the proposed production area, with no obvious grouping of wells. The Executive Director finds the baseline well locations acceptable, and has no reason to consider the locations invalid for providing unbiased groundwater quality data."

This response reveals a lack of understanding of how vitally important statistically unbiased samples are in estimating population parameters. It also reveals a total lack of understanding of how to evaluate whether a sampling procedure has adequately minimized selection bias.

Similar misunderstandings of statistical principles and applications are revealed in TCEQ's explanatory comments of the revisions to 30 TAC 331 which were published in the March 6, 2009, edition of the *Texas Register*. (Please find attached several pages from this edition with pertinent statements highlighted.)

You will note that some of the highlighted passages are well-written from a statistical standpoint. However, the recent comments from the Goliad County case, which I have just referenced, demonstrate that TCEQ often does not evaluate permit applications in a way which is consistent with their statements in the *Texas Register*.

As a case in point, note the green highlighted passage (34 TexReg 1668) re using the sample mean from small, skewed data sets to estimate the population mean. TCEQ's explanation here is appropriate, but they have no valid way of judging whether a sample is representative, and in practice, they do not require a company to use a non-parametric estimate such as the median even when it would be appropriate to do so.

For another example of the discrepancy between TCEQ's well-written statistical statements and their failure to follow them when they evaluate permit applications, note the green highlighted passage (34 TexReg 1650) re outliers.

The reference cited by TCEQ states that "improper sampling" is one reason for discarding outliers. However, TCEQ apparently does not understand that allowing companies to choose locations for baseline wells is an instance of "improper sampling." In the Vasquez mine case, (see INSERT 2) the outlier of 131 was included and the sample mean, rather than the sample median, is used to estimate the uranium restoration value. Similarly, in the Goliad County case (See INSERT 1) 804—a clear outlier—was not discarded.

Now note (34 TexReg 1668) the passage highlighted in pink for an example of an erroneous TCEQ recommendation. In this situation where data from a selected sample is used, there should be no discussion about the power of a statistical hypothesis test because it would be incorrect to perform such a test on this kind of data. (See the comments in INSERT 2 and also on the first page of this INSERT re the Shapiro-Wilk Test.)

TCEQ apparently does not recognize that it is incorrect to use selected sample data to perform a statistical hypothesis test for determining distributional characteristics of the population from which the selected sample was taken. This reveals a lack of understanding of when it is inappropriate and incorrect to use inferential statistical methodology.

Note also the pink highlighted passage (34 TexReg 1652). This passage reveals a lack of awareness by TCEQ that the Agency needs the help of credentialed statisticians in judging the validity of sampling designs.

Finally, a puzzling statement by TCEQ (34 TexReg 1652) is highlighted in yellow. This statement is especially perplexing since TCEQ claims that under their regulations, all samples must be representative—yet the regulations give no protocols to assure that samples are representative.

I will be glad to provide additional documentation upon request.

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Comment 94: GCGCD asked if the wells used for establishing baseline and restoration compliance are screened to sample the water through the entire thickness of the sand or just the ore body section, and, if the production sand zone is 75 feet thick and the ore thickness within that zone is twenty feet thick, is it statistically valid to collect a baseline water sample from only the ore layer in the water sand?

Response 94: The Executive Director determined that the applicant used appropriate screen lengths for the baseline wells. Each of UEC's 20 baseline wells were screened through the zone where uranium mineralization appears to be the most intense (based on gamma ray response), although the gamma ray response generally indicates uranium mineralization to some degree through the entire sand. The constituents for which baseline will be determined occur in the aqueous phase, which is to say they are dissolved in the groundwater. None of these fours sands is overly thick so the distribution of each of the constituents in the groundwater should be relatively uniform simply from mixing. Under these conditions, groundwater samples from each screened interval should be representative of groundwater quality in each respective sand.

Comment 95: GCGCD commented that the ore zone in the proposed exemption zone is only a fraction of the total aquifer exemption volume and asked if TCEQ is allowing baseline to be established with water samples collected only from ore zones, and if so, what is the statistical justification for this approach?

Response 95: The vertical extent of the proposed aquifer exemption is from the top of Sand A to the base of Sand D as depicted in the UEC application because uranium mineralization has been found in all four of the sands (A through D) of the Goliad Formation at the UEC site. The Executive Director notes that the area extent of the requested exemption includes the combined areas of the four sand layers identified in the UEC application (one in each of the four sands), even though no single ore body extends over the entire area requested for exemption. Because the areas of the ore bodies overlap, the Executive Director believes it would be appropriate to designate the combined vertical and area extent as the exempt aquifer, rather than designating four separate areas for exemption, one for each ore body, each with a corresponding vertical extent.

Comment 96: GCGCD asked, in evaluating groundwater quality data, what valid statistical procedures are used to test the sample populations for normal or log normal distributions.

Response 96: There are numerous methods for assessing whether or not data are from a normal or lognormal distribution. The Executive Director recommends use of the Shapiro-Wilk Test (for 50 or less sample results) and the Shapiro-Francia Test (for over 50 sample results) for making a decision to accept or reject normality or lognormality of a data set. [89]

[89] Robert D. Gibbons. Statistical Methods for Groundwater Monitoring, Chapter 11 (1994).

Comment 97: GCGCD asked if it is the TCEQ's policy to allow sample averaging of data when it does not follow a normal or log normal distribution.

Response 97: The Executive Director allows averaging of data if the data are from a continuous, infinite distribution. "Averaging" is equated with the statistical procedure called "x-bar," which adds all the values and divides this sum by the number of values. It also is called the sample mean. This method is an estimation technique and is used to estimate the true mean of distribution. It is the best linear unbiased estimation of the mean for any continuous, infinite distribution and is the minimum value unbiased estimator of the mean for a normal distribution.[90]

Comment 98: GCGCD asked, if the monitoring well ring is the point of compliance for restoration, is it statistically valid to collect baseline samples only from within the ore zone?

Response 98: The monitor well ring is used as the point of compliance to determine if there are excursions of mining fluids from the production zone; the monitor well ring is not the point of compliance for aquifer restoration. Aquifer restoration is required for the portion of the aquifer that is affected by mining solutions. This generally is the production zone within the production area. It is the groundwater in the production zone within the production area that is affected by mining and must be restored to pre-mining conditions as provided in 30 TAC § 331.107. Therefore, baseline groundwater samples used to determine restoration values are from wells completed in the production zone within the production area. Samples collected from wells completed in the production zone but outside of the production area (such as a monitor well) would not be representative of the groundwater within the production zone of the production area.

Comment 99: GCGCD asked whether the baseline samples were collected from a well that was screened only in the ore zone, or across the entire thickness of the sand; are the baseline monitor wells located randomly across the extent of the proposed well fields or biased toward the most concentrated ore zones; is there a sampling plan that prescribes how to locate the baseline monitor wells; and is there a procedure for collecting water samples including purging, stabilization, and filtering?

Response 99: Based on a comparison of the geophysical well logs for the 20 baseline wells to the well completion reports for these 20 wells,[91] baseline wells typically were screened across the zone with the highest gamma ray response, which should correspond to the zones with the highest uranium content. The TCEQ has no sampling plan that prescribes how to locate baseline monitor wells. Baseline wells should be located so as to provide representative groundwater samples from the production zone within the production area. Uranium concentrations from

[90] Richard O. Gilbert, Statistical Methods for Environmental Pollution Monitoring, 141 (1987).
[91] Both of these can be found in Appendix B of the application.

Comment 60
Richard and Catherine Bettge commented that water quality and quantity will not be restored to baseline levels after mining is complete because the drilling of exploration wells resulted in comingling and aeration of the water sands, resulting in inaccurate baseline data.

Response 60
The Executive Director does not agree that exploration or drilling activities prevent the accurate determination of baseline quality or affect restoration techniques. Exploration drilling involves no injection of fluids into the groundwater formation. The borehole is filled with drilling mud, and additional mud is added as the borehole depth is advanced. Because exploration wells drilled in this area generally are a few hundred feet or less in depth, they can be drilled in a day or two, limiting the amount of time the formation is exposed to the drilling mud. The Executive Director understands that some exploration boreholes were left unplugged beyond the time limits allowed by the Railroad Commission, but the Executive Director is not aware of contamination of groundwater that is attributable to unplugged boreholes. The Executive Director understands that the Railroad Commission investigated the concerns that UEC had left boreholes unplugged, and that the matter was resolved to the satisfaction of the RRC.

Comment 61
GCGCD expressed concern as to whether or not the water quality test used to develop restoration table values accurately represents the quality of groundwater prior to exploration. GCGCD stated they wished to participate in new verification water quality tests.

Response 61
As discussed in Response 61, the Executive Director finds no evidence that exploration drilling affected groundwater quality. Therefore, the Executive Director finds no need for new groundwater sampling to establish pre-mining groundwater quality. The TCEQ cannot require UEC to grant permission to GCGCD to enter property to take groundwater samples.

Comment 62
CBGSC asked how UEC guarded against selection bias when they chose locations for the samples of wells. Lynn and Ginger Cook commented that the statistical methodology used for determining baseline groundwater quality may provide biased values and should be considered invalid.

Response 62
The Executive Director reviewed the baseline information in the application and determined that it meets the requirements of 30 TAC §331.104. The Executive Director evaluated the location of the baseline wells by visual inspection of the well locations on Figure 1-4. Baseline wells are distributed throughout the proposed production area, with no obvious grouping of wells. The Executive Director finds the baseline well locations

acceptable, and has no reasons to consider the locations invalid for providing unbiased groundwater quality data.

Comment 63
GCGCD commented that the portion of the aquifer considered for exemption lies within the proposed monitor well ring. GCGCD also commented that because the monitor well ring is the point of compliance for migrating mining fluids, the entire volume of groundwater within the mine area will be contaminated by the mining process. Because of this situation, GCGCD contends that it is invalid to determine pre-mining groundwater quality only on data from analysis of groundwater samples collected from wells competed in the production zone within the production area, as this will result in a pre-mining groundwater quality that is biased high. By determining pre-mining groundwater quality in this manner, GCGCD concludes that UEC will be allowed to restore groundwater to artificially high values, thereby destroying good quality water that now exists throughout most of the mine area.

Response 63
The Executive Director notes that the area requested for an aquifer exemption extends beyond the mine area of the requested production area authorization.[72] The Executive Director does not agree that groundwater in the production zone throughout the entire mine area will be affected by *in situ* mining or that pre-mining groundwater quality should be based on data from analysis of groundwater samples from the production zone throughout the mine area, rather than just from the production area.[73]

The groundwater quality in the production zone within the production area, as least for certain constituents,[74] is different from that in the production zone from the perimeter of the production zone outwards to the monitor well ring. This is because the groundwater in the production zone within the production area is in contact with uranium mineralization, which affects the quality of that groundwater. Groundwater in the production zone outwards from the production area is not in contact with uranium mineralization, and therefore its quality is not affected by uranium mineralization. Data from analysis of groundwater samples collected from the production zone over the entire mine area would not be representative of groundwater quality in the production zone within the production area. Using data from analysis of groundwater samples collected over the entire mine area to determine the groundwater quality in the production zone within the production area would yield results that are biased low.

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[72] See Figure 1-3, Mine Location Map, UEC PAA1 application.
[73] The production area is that area defined by a line generally through the outer perimeter of injection and recovery wells used for mining (30 TAC §331.2(81), whereas the mine area is defined by a line through the ring of monitor wells installed to monitor the production zone (30 TAC §331.2(62). The production area lies within the mine area
[74] For example, the average groundwater values for uranium and radium-226 in the production zone within the production area are 0.115 mg/l and 333 pCi/l, respectively, whereas the average groundwater values for these two constituents in the production zone outwards from the production area are 0.02 mg/l and 12.1 pCi/L, respectively (Table 5.2 and Table 5.3, UEC PAA1 application).

tinguish between wells completed in the production zone of the production area and other wells. Mesteña recommended that proposed revised §331.107(1)(A) be revised to allow for baseline determination as is currently allowed under §331.104(d)(1). TMRA and URI submitted comments and recommendations similar to Mesteña's.

The revisions to §331.107(a)(1)(A) are based on the premise that groundwater quality in the production zone within the production area (that is, the area that contains the zone of uranium mineralization to be mined), may be, at least for certain constituents, different from the groundwater quality in the production zone outside of the production area (that is, the area of the production zone peripheral to, but beyond the mineralized area). For aquifer restoration, it is the quality of groundwater in the production zone within the production area that is of interest. It is this groundwater quality that represents the pre-mining groundwater quality of the zone to be mined, and that will be affected by in situ mining. Therefore, although the commission understands that any estimation of groundwater quality in any zone within any area is improved with additional data, all data used to determine groundwater quality should be representative of the particular groundwater. The groundwater quality data from the production zone outside the production area is not necessarily representative of the groundwater quality in the production zone within the production area. Therefore, the commission again emphasizes that the establishment of baseline for aquifer restoration (or for any groundwater baseline conditions, for that matter) should be based on representative data.

The commission acknowledges that under previous §331.107(d)(1), determination of baseline was based on the higher of two sample means: the sample mean of data from wells completed in the production zone of the production area (production area baseline wells); or the sample mean of data from wells completed in the production zone outside the production area (the production zoned monitor wells). The commission fails to understand, however, how this method provides a good estimate of the groundwater quality in the production zone within the production area. Using this methodology, a person is assuming two separate populations (the groundwater quality in the production zone in the production area, and the groundwater quality in the production zone outside the production area), computing a point estimate of the true mean of each population, and then choosing the higher estimate as representative of the true mean of the population represented by the groundwater in the production zone within the production area.

A more defensible methodology would be to use an appropriate statistical test to compare the two sample data sets to determine if they were from the same population. If the test indicated they were from the same population, then the sample mean could be computed using the combined data from both populations. Because of the increased sample size, this estimate of the true mean would have less associated variance than either estimate based on the separate data sets, and therefore would provide a better estimate of the true mean. The commission contends such a methodology could be proposed by an applicant under new §331.107(a)(1)(2).

The CBGSC also commented on proposed new §3312.107(a)(1)(A), stating that determination of restoration values on the sample mean from a limited sample data set was unadvisable because the sample mean is sensitive to extreme values (CBGSC provided an example based on data from the Vasquez Mine in Duval County to illustrate this effect). CBGSC recommended that in situations where the sample data set includes extreme values, the sample median should be used instead of the sample mean. An individual commented that companies are allowed to use a small sample size to calculate a sample mean, and if the sample data set contain outliers, the sample mean will be biased. The individual also commented that using a small sample data set to identify the distributional characteristics of the underlying distribution is not a statistically sound practice.

The commission agrees that the sample mean can be influenced by extreme values, be they extremely high or extremely low, and that extreme values have less effect on the sample median. The method described in new §331.107(a)(1)(A) presently is allowed under §331.104(d)(1) and was retained to allow its use, albeit in a more restricted manner in that restoration values must be based on data from wells completed in the production zone within the production area. In such cases as the example provided by CBGSC, the commission can determine that a sample data set is not representative, as required under revised §331.104(a), and require additional samples from existing baseline wells or the completion of additional baseline wells. Alternatively, under new §331.107(b), the commission may allow use of the sample median. The commission notes that in the case of a small data set that has an extreme value, which can significantly affect the sample mean, use of the sample median is a example of accommodation of an outlier. The commission also agrees that the power associated with a statistical hypothesis test used to determine the distributional characteristic of the population from which the sample is drawn will increase as the sample size increases (the term "sample size," as used in statistics, refers to the number of realizations drawn from a population; that is, the number of samples taken). Any test for determining normality should be done using a suitable sample size, and the commission would take this factor into consideration regarding any test used to test data.

KHH commented that under proposed revised §331.107(d), the informational requirements for the semi-annual aquifer restoration report are burdensome to both the operator and the commission, and that the informational requirements for water levels, hydrographs, and potentiometric maps provide no meaningful measure of aquifer restoration progress. KHH suggested these requirements be eliminated.

The purpose of the revisions to §331.107(d) was to identify specific information that should be included in these semi-annual reports. The requested information is the type that typically is collected during restoration activities. With regards to potentiometric maps, the commission considers such maps a basic element of any groundwater report. However, the requirement for hydrographs of each baseline and monitor well is not essential to evaluating aquifer restoration progress. Section 331.107(d) is revised to remove this requirement.

TMRA commented that the wording "have been restored to the values. . ." at proposed new §331.107(e) is inconsistent with the wording "levels consistent with the values. . ." as used in §331.107(b). Different wording invites confusion unless it is meant to indicate a different threshold. If it does indicate a different threshold, the difference in thresholds is unclear as well as why a different threshold is intended.

The commission agrees with this comment, and notes that the definition of the term "restored aquifer" at §331.2(89) was revised to delete the phrase "levels consistent with restoration table values or better as verified by an approved sampling program" in

tive, as required under §331.014(a). No changes were made in response to this comment.

GCGCD and STOP also recommended for baseline samples in the mine and production areas: "(3). Valid statistical tests shall be performed on the water quality data for each well to remove outliers and determine the distribution of the data. If data for a groundwater quality parameter are distributed normally or log-normally, the mean (average) may be calculated (minus outliers) for that parameter. For data that are not distributed normally or log-normally, the median value shall be used for the parameter (minus outliers), or additional samples may be collected to retest the distribution. If outliers are removed, a minimum of three samples must remain to calculate the mean or median for a parameter."

The commission agrees that "valid" statistical methods should be used in any statistical analysis, and a discussion of the term "valid" is provided in a previous response. However, the commission opposes the arbitrary elimination of outliers. Although statistical tests should be performed to identify any potential outliers, the commission does not agree that all outliers should be summarily discarded. Any outlier (either high or low) should not be discarded unless it is determined its value was the result of a typographical or transcription error, faulty analysis, or improper sampling. Methods may be used to accommodate an outlier (for example, see Outliers in Statistical Data by V. Barnett and T. Lewis, 1994, 3rd edition, John Wiley and Sons), but one should never be discarded except under the above-mentioned circumstances. Also, the commission notes that the sample mean (average) is a point estimate of the true mean of a distribution, and the sample median is a point estimate of the true median of a distribution. For a normal distribution (or any other symmetrical distribution, for that matter), the true mean equals the true median, whereas in a log-normal distribution the true mean is greater than the true median (see Statistical Methods for Environmental Pollution Monitoring, 1987, by Richard O. Gilbert, page 171). Therefore, the commission does not see the logic in using the sample mean for data presumed to be from a population characterized by a normal or log-normal distribution, but using sample median for data presumed not to be from a population characterized by one of these distributional types. Lastly, the commission notes that use of the sample median is a method used to accommodate outliers. No changes were made in response to this comment.

GCGCD and STOP also recommended for baseline samples in the mine and production areas: "(4). If multiple wells are installed at a monitoring location, the mean or median from each well will be used to determine the baseline value for each parameter at the well location. A valid statistical test will be performed with the mean or median values to determine the distribution of each parameter. If a normal or log-normal distribution is demonstrated, the mean (average) can be calculated for the parameter. For data that do not follow a normal or log-normal distribution, the median value shall be used to represent the parameter for that well location."

The commission agrees that all wells installed at a monitoring location should be sampled. However, with regards to use of the sample mean or sample median, the commission offers the same explanation provided in response to the commenters' item (3). That is, the commission does not agree that a sample mean should be used for data presumed to be from a normally or log-normally distributed population and that a sample median should be used for data presumed to be from a population that is not normally or log-normally distributed. No changes were made in response to this comment.

GCGCD and STOP also recommended for baseline samples in the mine and production areas: "(5). Baseline water quality in the mine area and production area will be established independently and calculated using the mean or median for each parameter from each well location. A valid statistical test will be performed with the mean or median values to determine the distribution of each parameter."

The commission agrees that groundwater quality in the baseline wells should be established independently from groundwater quality in the monitor wells, but again emphasizes that groundwater quality in the baseline wells (those wells completed in the production zone of the production area) is to be used for aquifer restoration goals and groundwater quality in the monitor wells is to be used for detection of excursions. With respect to the suggested use of mean and median, the commission does not agree that a sample mean should be used for data presumed to be from a normally or log-normally distributed population and that a sample median should be used for data presumed to be from a population that is not normally or log-normally distributed. No changes were made in response to this comment.

GCGCD and STOP also recommended for baseline samples in the mine and production areas: "(6). The baseline water quality for the mine area and production area will serve as the restoration values for the mine area and production area. Each area will be restored to its pre-mining baseline levels."

The commission again emphasizes that aquifer restoration is required for the area where the production zone is mined using in situ techniques; that is the production zone within the production area. It is the groundwater in this zone within the production area that is affected by injection of mining fluids, and therefore must be restored to pre-mining conditions. For the mine area, which is the area enclosed by the ring of production zone monitor wells that surround the production area, groundwater quality is determined so that any injected mining fluids that migrate from the production zone within the production area can be detected. Because mining fluids are not purposefully injected into the production zone outwards from the production area, this part of the production zone should not be affected by mining fluids, except for short periods of time during an excursion. All excursions must be addressed in accordance with the existing requirements in §331.106. No changes were made in response to this comment.

For baseline samples for the monitoring well ring, GCGCD recommended a methodology consisting of six items. Items 1 through 5 in this recommended methodology are identical to items 1 through 5 of their recommended methodology for baseline samples in the mine and production zone, in items 1 through 5 for the production areas. For these five items, the commission's responses are identical, respectively, to the responses to items 1 through 5 of GCGCD's recommended methodology for baseline sample in the production and mine area. Item 6 of GCGCD's recommended methodology for baseline samples for the monitor well ring was as follows: "(6). Upper control limits for excursions will be calculated for the baseline values using a valid statistical test (e.g., upper 95% confidence interval)."

The commission agrees that the term "control parameter" is defined at §331.2(28) as a groundwater constituent monitored on a routine basis to detect or confirm the presence of mining solutions in a monitor wells. The term "upper limit" is defined at

Sierra Club and STOP recommended the proposed rules be revised to include the following specific requirements: 1) A statistically valid number of monitor wells in the production zone, including the strata above and below the mining, sufficient to determine the water quality and detect any excursion in a timely manner; 2) A valid and accurate statistical testing of the monitoring wells to determine pre-mining baseline; 3) Upper control limits based on a valid statistical test or the monitor well baseline, such as the upper 95% confidence interval; 4) Nested wells where the thickness of the sand is too great for a single screen interval; 5) Restoration of the Mine Area and the monitor well area to actual pre-mining concentrations; and 6) Notice requirements to the TCEQ and property owners within two hours if there is a change in concentration of any constituent which may affect drinking water quality of a private well.

The commission offers the following comments on each of these respective suggested requirements: 1) The commission is unclear as to the meaning of "a statistically valid number of monitor wells." The number of monitor wells should be dependent on such considerations as geology and hydrogeology, and the commission is uncertain how this would be determined in a statistical manner. No changes were made in response to this comment; 2) The commission agrees that determination of pre-mining baseline for excursion detection is essential, and notes this subject is addressed in new §331.104(e). Under new §331.104(e), any statistical test chosen by an applicant or operator must be approved by the executive director, who will evaluate the proposed method. No changes were made in response to this comment; 3) As expressed in the previous comment, the commission agrees that determination of baseline for excursion detection should be based on appropriate statistical tests. With regards to the provided example of an upper 95% confidence interval, the commission notes that use of this method carries the same observations e commission makes in a subsequent response regarding use a tolerance interval. That is, the commission does not agree nat a tolerance interval methodology must be used, but that the choice of statistical method for a hypothesis test should be based on the appropriateness of the method to the distributional characteristics of the data. No changes were made in response to this comment; 4) The commission agrees that multiple monitor wells may be necessary at a single monitoring location in certain circumstances, such as excessive sand thickness. However, the commission can require such wells, when necessary, under §331.103, Production Area Monitor Wells. No changes were made in response to this comment; 5) The commission disagrees that aquifer restoration should be required for the area between the production area and the surrounding monitor well ring. It is within the production zone of the production area that mining fluids are injected, and it is groundwater in this zone within this area that will require restoration. Any excursions of mining fluids from this zone will be detected in the monitor wells, prompting remediation of the excursion in accordance with the requirements of existing §331.106. No changes were made in response to this comment; and 6) Under proposed §331.106, an operator is required to notify the commission of any excursions, sample the affected wells for an expanded list of groundwater parameters, and initiate actions to clean up the groundwater in the affected wells to baseline quality for the monitor wells. Also, when mining fluids are present in a monitor well, the operator must increase the sampling frequency to twice a week (§331.105(4)). These actions provide a rapid response to an excursion, and are designed to ensure an excursion is contained and remedied, preventing it from further migration and possibly affected off-site wells. Although the commission can and would notify any property owner if it thought an excursion could affect that property owner's well, it sees no need to require notification of landowners in the event of any excursion. In addition, the executive director is required under TWC, §5.235 to notify a county judge and county health officials when the executive director acquires information that confirms that a potential public health hazard exists because usable groundwater has been or is being contaminated. No changes were made in response to this comment.

CBGSC commented that a valid statistical analysis of sample data requires samples to be obtained from wells located on a systematic grid across the entire mining areas surrounded by monitor wells or randomly selected with an appropriate statistical procedure, and that no such requirements for locating baseline wells are included in the proposed rules. CBGSC emphasized that without these requirements, data resulting from sampling of baseline wells cannot be representative in a statistical sense, and will not yield valid statistical results.

The commission agrees that data used to establish baseline should be representative of the groundwater for which baseline is to be established. In evaluating an applicant's proposed baseline determination, the commission takes into consideration whether the samples used to establish baseline are representative, and has revised §331.104(a) to require representative samples. Obtaining representative samples would certainly involve evaluation of the locations of baseline wells, and any evaluation by the commission regarding whether samples are representative would include consideration of how the baseline wells were located.

CBGSC recommended that because data obtained from sampling of baseline wells are all-important in establishing aquifer restoration values, the commission should consult with the most highly qualified statisticians specializing in applied sampling design in order to establish protocols for obtaining a systematic or random sample of baseline wells. CBGSC emphasized that establishment of such protocols would assure that data used to determine aquifer restoration values are statistically sound.

The commission appreciates that there are statisticians that specialize in sample design, and that the establishment of such protocols are valuable in assuring that aquifer restoration values are determined in a statistically sound manner. The commission notes that there are agency employees that have statistical expertise to address issues, such as sample design, and that numerous guidance documents and texts on statistical analysis also are available to agency staff.

An individual commented that they were surprised to learn that groundwater at in situ uranium mining sites in Texas has never been restored to pre-mining groundwater quality.

Commission records indicate that with the exception of one production area authorization (Production Area Authorization UR01941PAA3 at COGEMA's O'Hearn Mine), aquifer restoration values at all other sites were amended to allow for higher concentrations of certain groundwater constituents to meet aquifer restoration requirements. As discussed in a previous response, the commission notes that at these sites, the concentration of many of the groundwater constituents were reduced to the initially-established aquifer restoration values, but that for other constituents, concentrations were reduced by restoration efforts, but not to the initially-established restoration values. All amendments to restoration values were in accordance with the requirements of existing §331.107(f). The commission also

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MA / Mathematics, 1965
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POSTGRADUATE COURSES:

Demography, 1977
Analysis of Categorical Data, 1976
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Design of Experiments, Special Topics in Biostatistics, 1975
VANDERBILT UNIVERSITY MEDICAL SCHOOL

Statistics and Disease Control, Statistics and Health Services, 1974
Sampling Human Populations, Intermediate Biostatistics, 1973
UNIVERSITY OF TEXAS SCHOOL OF PUBLIC HEALTH

Theory of Statistics, 1972
Statistical Methods, 1972
Vector Spaces, 1969
TEXAS A. AND I. UNIVERSITY

Linear Algebra, Real Analysis, 1970
COLORADO COLLEGE

Selected Topics in Modern Mathematics, 1963
UNIVERSITY OF TEXAS AT AUSTIN

PROFESSIONAL EMPLOYMENT:

Professor of Mathematics, 1985 - 1997
Associate Professor of Mathematics, 1977 - 1985
Assistant Professor of Mathematics, 1972 - 1977
Instructor of Mathematics, 1967 - 1972
DEPARTMENT OF MATHEMATICS, DEL MAR COLLEGE

PREVIOUS EMPLOYMENT:

Teacher of High School Mathematics
PUBLIC SCHOOLS, Corpus Christi, Texas

Teacher of Junior High School Mathematics
PUBLIC SCHOOLS, Kingsville, Texas

Teacher of High School Science and Mathematics
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PART-TIME APPOINTMENTS:

Sabbatical Lecturer, Department of Mathematics and Statistics
UNIVERSITY OF MASSACHUSETTS AT AMHERST

Teaching Assistant in Statistical Epidemiology,
Department of Biostatistics
HARVARD UNIVERSITY SCHOOL OF PUBLIC HEALTH

TRAINEESHIPS/ FELLOWSHIPS:

Sabbatical Lectureship in Statistics, 1981
UNIVERSITY OF MASSACHUSETTS AT AMHERST

NSF Faculty Fellowship in Science, 1976 - 1977
HARVARD UNIVERSITY SCHOOL OF PUBLIC HEALTH

Traineeship Grants from U. S. Public Health Service, 1974 - 1975
UNIVERSITY OF TEXAS SCHOOL OF PUBLIC HEALTH
VANDERBILT UNIVERSITY MEDICAL SCHOOL

NSF Summer Institute for College Mathematics Teachers, 1970
COLORADO COLLEGE

NSF Academic Year Fellowship, 1964 - 1965
UNIVERSITY OF ILLINOIS AT URBANA

NSF Summer Institute for Secondary School Mathematics Teachers, 1963
UNIVERSITY OF TEXAS AT AUSTIN

PROFESSIONAL ACTIVITIES RELATED TO FACULTY POSITION:

Designed and monitored statistics curriculum. Analyzed data and consulted with administrators and colleagues in many disciplines -- including health sciences. Served on numerous college-wide and departmental committees. Taught five, sometimes six, classes per semester. Actively participated in proceedings of the National Council of Teachers of Mathematics. Reviewed eight mathematics manuscripts for Wadsworth Publishing Company.

OTHER PROFESSIONAL ACTIVITIES:

Consulted with a member of Pharmacy Administration at Spohn - Memorial Hospital re data on ciprofloxacin. Consulted with a physician re cervical dysplasia and HPV data. Consulted with a physical therapist re knee function data. Served as moderator for a conference of scientists and government officials re pesticide problems in South Texas. Provided testimony to the Texas Department of Agriculture on behalf of the Texas Pesticide Abuse Coalition. Reviewed a manuscript for a text in statistical epidemiology for Dr. Colin White, Professor of Biometry, School of Medicine, Yale University. Worked with the Director of Research at Corpus Christi State School re data analysis for one of the school's training programs. Worked with a pre-medical student to analyze data from Boston Childrens' Hospital.

PUBLICATIONS:

Scheurich, Venice; Graham, Billie; and Drolette, Margaret: *Expected Grades Versus Specific Evaluations of the Teacher as Predictors of Students' Overall Evaluation of the Teacher.* Research in Higher Education, Vol. 19, No. 2, 159 - 173, 1983.